GOVERNMENT OF PORTO RICO
DEPARTMENT OF AGRICULTURE AND LABOR
INSULAR EXPERIMENT STATION
RIO PIEDRAS, P. R.

CIRCULAR No. 88

SPRAYING CITRUS FRUITS IN PORTO RICO

BY

MELVILLE T. COOK,
Plant Pathologist

H. L. DOZIER,
Entomologist

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SPRAYING CITRUS FRUITS IN PORTO RICO

MEL. T. COOK, Plant Pathologist
H. L. DOZIER, Entomologist

This is a preliminary circular prepared for the purpose of calling the attention of the citrus growers to: (1) the most serious diseases and insects of citrus fruits in Porto Rico, (2) the most generally accepted methods of spraying, and (3) the methods for the preparation of Bordeaux mixture and oil emulsions. The many pests of citrus are subjects of special studies and a more extensive publication will be issued later.

THE MOST IMPORTANT DISEASES

The most serious disease of citrus fruits in Porto Rico at this time is the "lemon or citrus scab". This publication will deal primarily with this disease. Other diseases of importance which can be held in check by spraying are "melanose", "anthracnose", "diplodia stem and fruit diseases", and the "tear stain". The anthracnose is the most important disease of the orange. If the scab of the grape fruit and the anthracnose of the orange are held in check, the losses from the other diseases referred to above are not likely to be of much importance. However, other diseases, such as "stem end rot", may at times cause heavy losses.

Citrus Scab.

This is a disease which is very common on fruits, leaves and sometimes on new growths. It is the most serious of grape-fruit diseases in Porto Rico (Fig. 1). It checks the growth of the trees and gives them unsightly appearance, but it is of greatest importance on the fruits. Any considerable amount of this disease on the fruit renders it unfit for the markets in the States. A small amount of infected fruits will be consumed on the local market, but most of it must go to the cannery or be a total loss. This disease appears to have originated in some part of Asia which is also the home of the citrus fruits. The old Japanese literature contains descriptions which indicate that scab has been there for a century or more. Although the disease has travelled around the world, it has not been reported from the Philippine Islands nor California. The disease was first reported from Porto Rico in 1901, but may have been here for many years previous to that date.

The disease is caused by a fungus (*Cladosporium citri* Massee)[1] and moisture is necessary for infection and development; therefore, we find our greatest amount of scab when we have had a heavy rain fall during the period of new growth and blooming. Experimental work in other places indicates that the most favorable temperature is from 65° to 70° F.

The first indication of the disease is small, light green spots which develop into warts, which in turn become corky and brown or dull red in color. These corky warts vary in size, but frequently unite so that large areas and sometimes the entire surface of the fruit is covered with them. Seriously infected leaves are very much distorted.

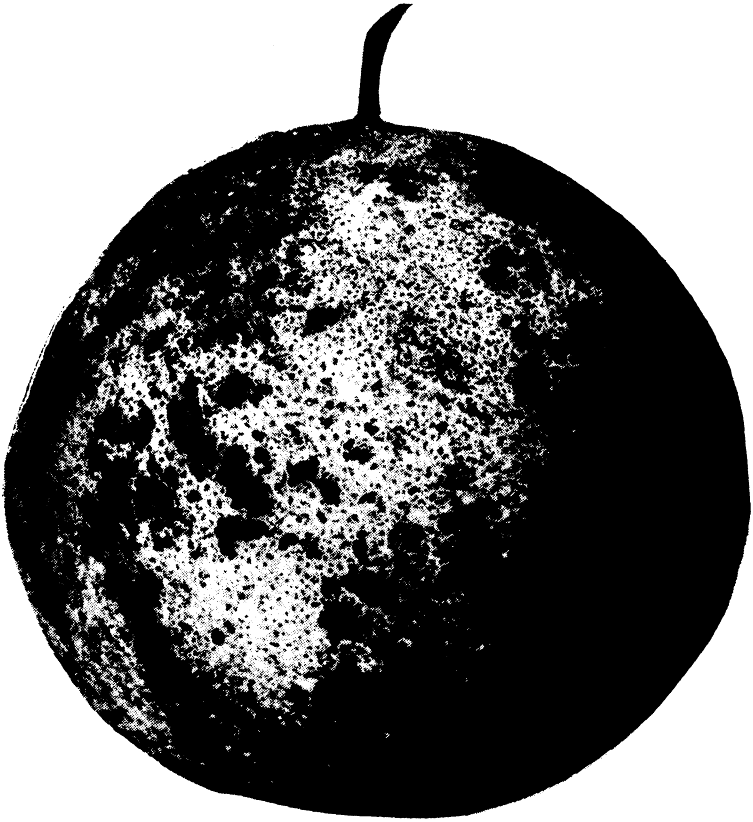

FIG. 1.—Grapefruit infected with Scab

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[1] Recently described by Anna C. Jenkins of the U. S. D. A. Bureau of Plant Industry under the name of *Sphaceloma fawcettii.*

Greasy Spot or False Melanose.

The "greasy spot" or "false melanose" is the next most prominent disease. It is primarily a disease of the leaves and the cause is unknown. It produces numerous brown or black, smooth spots which are most prominent on the under surface of the leaves. A disease of this kind cannot do other than weaken the tree, although it is difficult to determine the extent of the injuries. Fortunately it does not attack the fruit. No control has been devised.

Melanose.

"Melanose" is a disease which appears to be of less importance in Porto Rico than in some other citrus-growing regions. This disease is caused by a fungus (*Phomopsis citri*) which attacks the leaves and twigs when young, producing great number of small corky spots about one-sixteenth of an inch in diameter. They are at first yellow, but later become brown and sometimes black. It attacks the fruit at any age producing the "tear stain" and also a "stem end rot". This disease can be found in many groves, but is not abundant. It does not appear to be of great importance in Porto Rico.

Anthracnose or Wither Tip.

The "anthracnose" or "wither tip" is a disease which is very widely distributed in citrus-growing countries. It is very common in Porto Rico, especially on the orange, but it is difficult to determine the extent of the injuries. It is caused by a fungus (*Colletotrichum glœosporiodes*) and this same or very closely related fungi attacks the mango, avocado and other fruits. It attacks the leaves, causing more or less circular brown or gray spots with definite outlines. It attacks the twigs, causing a "wither tip" or "die back".

Sometimes it attacks the blossoms and causes the young fruits to fall. Fruits varying in size from the very smallest up to those one inch in diameter fall in great abundance. These fallen fruits develop black spots from which this fungus is easily obtained. The fungus can also be obtained from the stems at points of union with the fruit. It attacks older fruits, causing brownish spots of various sizes which are usually sunken and usually develop into a soft rot. Many of these spots start from insects or other injuries which become infected with the fungus. This form of the disease is most common on oranges. This disease may also cause the "tear stain" markings.

Stem End Rot and Die back.

"Stem end rot" and "die back" is a disease of the fruit with which our growers are familiar. It may be caused by the "melanose" fungus (*Phomopsis citri*) to which we have previously referred or it may be caused by another fungus (*Diplodia natalensis*) which is quite common in Porto Rico. *D. natalensis* is of much greater importance in Porto Rico than *P. citri.* These fungi will also cause a die back of the young growth. These fungi also live on the dead bark of the citrus from which the spores pass to the fruit. The "stem end rot" can be reduced to some extent by spraying.

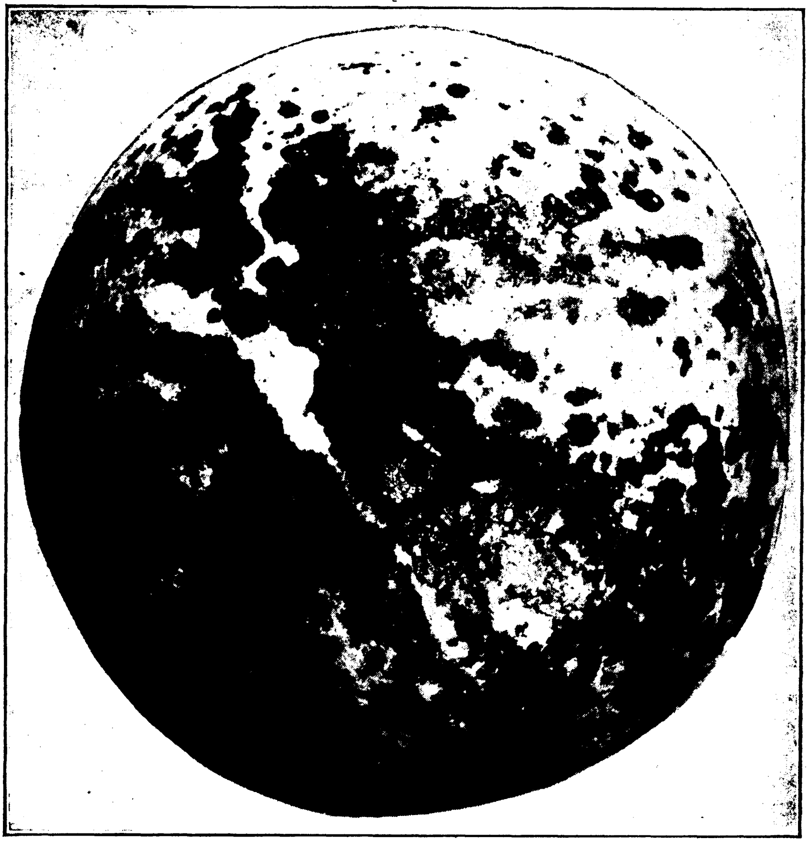

FIG. 2.—Grapefruit infected with Tear Stain

Tear Stain.

"Tear stain" is a disease which may be caused by the melanose fungus (*Phomopsis citri*) or by the anthracnose fungus (*Collet-otrichum glœosporiodes*) or by the rust mite (*Phyllocoptes oleivorus*). It is impossible at this time to say just which of these organisms is the most important factor in this disease. It is possible that it may sometimes be due to oil burning. (Fig. 2.)

From the preceding discussion, it will be seen that "die back", "stem end rot", and "tear stain" may be due to two or more causes.

CONTROL

1. It is advisable to cut out and burn the dead wood. This will reduce the source of infection from *Colletotrichum glœosporiodes, Diplodia natalensis,* and *Phomopsis citri.* Since these fungi persist for some time in the dead wood, it is necessary that it be burned.

2. It is advisable to remove the drop fruits from the grove. They carry fungi and are sources of infection long after they are supposed to be of no importance.

3. Spray with Bordeaux oil (see page 10). The number and frequency of the treatments will of course vary with the length of the blooming season and the frequency of the rainfall. In most cases it may be desirable to spray about every ten days. If there is excessive rainfall, spray every week, but if the season is rather dry, spray every two weeks.

The first spray should be applied just before or at the time of blooming. It is very doubtful if the "clean up" spray which is given by some of our growers previous to the appearance of the new growth and buds is of sufficient importance to pay the cost of material and labor. Because (1) most of the spores are so enclosed and protected that the spray cannot reach them; and (2) very few spores are killed previous to germination. Therefore, it is necessary to keep the tender growths covered so far as possible with the spray mixture so that spores which fall on these tender parts will be killed upon germination and before they can penetrate. It is necessary that the spraying be done thoroughly, otherwise spores may fall on small areas which are not covered by the spray mixture, germinate and penetrate (Fig. 3). After a fungus has penetrated a new fruit or other tender growth, spraying will not kill it.

A *coarse spray* leaves wide areas between large spots of spray materials; this permits spores to germinate and penetrate without coming in contact with the spray mixture. A *fine spray* leaves narrow areas between small spots of spray materials; when a spore germinates it usually comes in contact with the spray material and is killed before it can penetrate (Fig. 3). *A fine spray nozzle and high pressure saves material and gives the best results.*

While other spray mixtures are used by some of our growers with success, Bordeaux oil is more generally used in citrus-growing countries than any other preparation.

The objection to the use of Bordeaux mixture is that it kills some of the entomogenous or beneficial fungi which holds the scale insects in check. It is true that Bordeaux mixture does destroy a part of these entomogenous fungi which makes it necessary to use the oil in order to hold the scale in check but Bordeaux mixture at the present time is the best fungicide known for the control of the citrus scab fungus. Therefore, it appears at this time that if our growers wish to secure the highest-grade fruit, that it will be necessary to use Bordeaux oil. In groves where there are few scale insects it may be possible to omit the oil from the first two or three treatments, but it should certainly be used in the last two or three treatments.

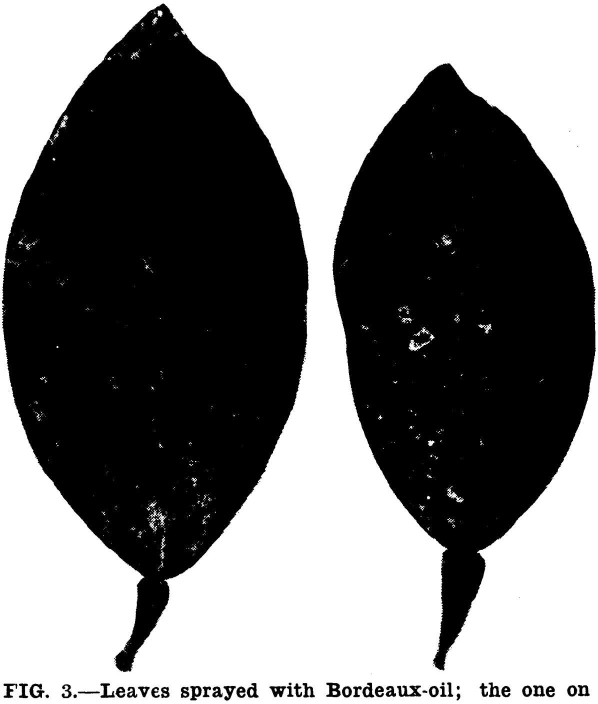

FIG. 3.—Leaves sprayed with Bordeaux-oil; the one on the left properly sprayed, the one on the right poorly sprayed.

Stand near the trunk and spray the inside of the tree first.

Be sure to spray the young leaves and young fruits.

Do not neglect to spray the top of the tree.

If you use a marker, such as calcium caseinate (page 18), the trees can be examined when dry and the efficiency of the workmen determined. This is very important. Some of our growers spend enough money on spraying to get good results and fail because the work is not done properly. A tree may appear to be well sprayed when examined at a distance, but a close examination will show that the young fruits have been missed or poorly sprayed. Such work is a waste of money and time.

Do not spray when the trees are wet; it will not stick. If well-made mixture dries before the rain comes, it will stick; but if it does not have time to dry, it will not stick.

Spraying with Bordeaux mixture may be followed by outbreaks of scale insects and rust mites. In case of an outbreak of scale insects, spray with oil emulsion (see page 15). In case of an outbreak of rust mites, spray with some sulphur preparation (page 17) or dust with sulphur dust (page 18).

Personnel.

There are many ways in which spraying may go wrong. *Therefore, much depends on the care with which the materials are mixed and the applications made.* No one should be employed for this work, except the most intelligent and careful laborers. In fact, it is very important that the grower should give personal attention to this work so far as possible.

Equipment.

A good equipment is necessary to good work. The necessary equipment is as follows:

(*a*) A good spray machine with pressure of 200 to 300 pounds. A high pressure is necessary for good spraying.

(*b*) Not less than six good barrels, two for copper sulphate solution, two for milk of lime and two for oil emulsion. While three barrels are in use for supplying the machine, the other three may be used for making new supplies of material so that there may be no delay in the work.

(*c*) Two or more strainers made of fine wire stretched on the bottoms of boxes made to fit in the opening in the top of the spray tank. The materials tend to destroy the wire screen very quickly; therefore, always have an extra strainer ready for emergency. Use only one layer of wire in the strainer: two layers will cause a clogging with solid materials.

(*d*) Several fine-spray nozzles. These nozzles wear and must be changed frequently in order to get a fine, mist spray. The disk nozzless are usually considered most satisfactory.

(*e*) The spray gun saves time and labor but uses more material than the long rods.

(*f*) If the grove is at a considerable distance from the water supply, it is advisable to have an extra team for hauling water and spray materials to the spray machine. This will save time and cost of labor.

Materials.

Good materials are just as necessary for success as good equipment. They are as follows:

(*a*) Copper sulphate which should be dissolved in water at the rate of one pound to one gallon. Suspend the copper sulphate in a cloth bag at the surface of the water. Always use a wooden container. This process may be hastened by pulverizing the copper sulphate or by heating the water or by doing both.

(*b*) Live lime (*i. e.*, burned lime stone). Put 75 pounds in a barrel and add enough water to slake. This will be accomplished more rapidly by using warm water. When thoroughly slaked, add 50 gallons of water.

(*c*) Oil emulsion at the rate of 3 quarts of the standard oil emulsion to each 50 gallons of spray. (See page 15).

(*d*) *Water.*—Soft water is very necessary for the making of good oil emulsion with soap. If hard water is used, it should be treated with caustic potash to soften it before using. The amount of potash will vary with the degree of hardness of the water.

Making of Bordeaux.

Fill a tank almost full of water. If a hundred-gallon tank, put in about 80 gallons of water. Start the agitator. Put the strainer on the opening. Put in six gallons of copper sulphate solution. Add nine gallons of milk of lime *slowly*. *Never mix the copper sulphate and milk of lime concentrated. Always dilute one before adding the other. Add six quarts of the oil emulsion.* Add enough water if necessary to make the one hundred (100) gallons. *Keep the agitator going and use immediately. Bordeaux mixture spoils very quickly if allowed to settle.*

The Bordeaux will reduce the scab, melanose and anthracnose.

It will not be of much value in the control of the greasy spot.

The oil will control the scale insects.

If the Bordeaux mixture is improperly made, it will burn the fruit and foliage. It may be tested by dropping a little yellow prussiate of potash (POISON) into a cup of the mixture; the formation of a dirty brown precipitate indicates that more lime should be added.[1]

Application.

Apply with a pressure of about 250 pounds and always use a fine nozzle so as to throw a fine mist. Do not use an old nozzle. One hundred (100) gallons will spray 10 large trees, 15 medium-sized trees or 20 small trees.

The new foliage, flowers, and fruits should be thoroughly covered and this cannot be accomplished unless you use a high power and a fine nozzle (Fig. 3).

A tree may receive the full amount of spray mixture necessary and may have the appearance of being well sprayed, but unless the young fruit is well covered the results will be unsatisfactory. It is also important to cover the young leaves. The covering of the old leaves is of little importance. The covering on the lower surface is more important than on the upper surface.

It is doubtful if any application previous to the new growth and bloom will pay for the expense. The infection takes place when the leaves and fruits are young, but the scab cannot be recognized until it reaches the eruptive stage some weeks later. Most of the leaf infection takes place before the leaves are one inch in length and most of the fruit infection before the fruits are 1½ inches in diameter. These young leaves and fruits must be thoroughly covered to prevent infection. Fruits that are protected from the spray by foliage, frequently show scab, while fruits which receive the spray are clean. A high power blows the leaves back and covers the young fruit, if properly directed.

The number of treatments will depend on the length of the blooming season and the amount of rainfall. Ordinarily it will not be necessary to spray oftener than every 10 days or two weeks, but in rainy weather it may be necessary to spray more often.

Do not spray immediately following a rain. It will not stick. Give the leaves a chance to dry before spraying. A heavy rain before the mixture is dry will wash it off and it will be necessary to spray again.

After finishing the season spraying with Bordeaux-oil, the grower should keep a close watch on the trees for rust mites and scale insects. At the first appearance of rust mites, he should spray with some sulphur preparation (see page 17). At the first appearance of scale crawlers, he should spray with oil emulsion (see page 15).

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[1] If the lime is poor grade, use more of the milk of lime.

Injuries.

Injuries may result from using improperly made Bordeaux mixtures, poorly made oil emulsion or from spraying under a very hot sun. *Use your head.*

Cost of Spraying.

The cost will vary with many factors, but should not exceed 10 cents per application per tree. If the grower is well equipped to do the work, it will cost less.

Cleanliness.

Be sure that the tank, hose and nozzles are cleaned. They should be washed at the end of the day's work. If the machine has been used for churning oil emulsion, all parts should be washed before beginning to spray.

MOST IMPORTANT INSECTS

The insects attacking citrus may be roughly treated under three natural groups:

(1) The Sucking Insects which feed by sucking out the juices by means of their tube-like beaks. This group is the largest and most injurious that the citrus grower has to deal with, including the scale insects, mealybugs, whiteflies, leafhoppers, the flower thrips, and the plant lice. Contact insecticides, such as oil emulsions, nicotine sulphate, etc., must be used in controlling *members* of this group.

(2) The Leaf-feeders, which are supplied with strong mandibles and therefore, obtain their foods by chewing and swallowing the leaf material. Among these are the adult may beetles (*caculos*), the root-borer (*vaquita*), the smaller green leaf curculio and several katydids. As these are all chewing insects, a stomach poison must be used such as some of the arsenicals (lead arsenate, Paris green or sodium fluosilicate), in combination with lime.

(3) The Mites which eat by scraping the leaf surface or extracting the oil from the epidermal cells. Among these is the rust mite which probably causes the greatest annual loss to the citrus growers. Red spider mites also do considerable damage at times. These are controlled almost exclusively by the use of sulfur either in the form of a liquid spray (lime-sulphur 1:70) or sulfur dust.

The Scale insects are by far the most important group of insects attacking citrus and are briefly discussed here. There are many growers on the Island who depend entirely on the aid of the beneficial fungi in controlling the scale insects and do not spray at all.

This method consists of merely planting a suitable wind brake on the windward side of the grove which increases the shade and humidity in the grove and thereby makes the conditions more suitable for the growth of a number of species of native beneficial fungi. While on certain properties, where the conditions are unusually and peculiarly favorable, the scales are held in rather complete control, the majority of the properties must be kept clean by continual spraying with Bordeaux-oil or plain oil emulsion.

Most of our scale insects have about the same life history, the eggs hatching beneath the mother scale covering and the young "crawlers" which are very flat and resemble very small mites, insert their beaks and then "settle" down to the formation of their scale covering and development. It is during this young tender stage that they are most susceptible to spraying.

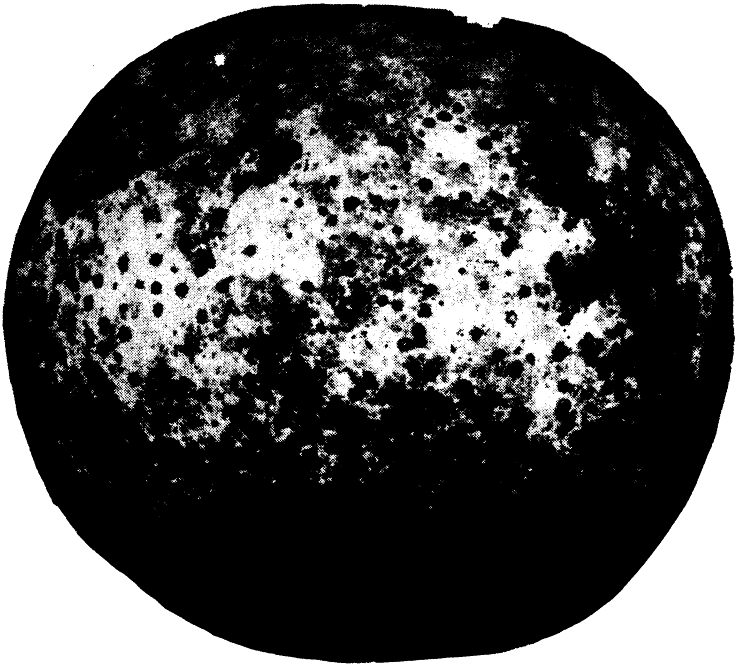

FIG. 4.—Fruit infected with West Indian Rufous Scale

The Purple Scale (*Lepidosaphes beckii*) is usually the most serious of the scales attacking citrus. While it attacks both the leaves, fruit, and twigs, it is by the killing back of the latter and the devitalization of the tree itself that the most damage is done. The general brownish-purple color of the scale covering gives this insect its common name of Purple Scale. It is from one-tenth to one-seventh of an inch in length and in shape exactly duplicates an oyster-shell, being somewhat curved or horn-shaped.

The Snow Scale (*Chionaspis citri*) gets its common name from the white color of the male scales. They are found in large colonies along the trunk and larger branches and undoubtedly constitute a constant drain on the tree. This is one of our most common injurious scales.

The West Indian Rufous Scale (*Selanaspidus articulatus*) (Fig. 4), primarily a leaf scale, is also commonly found on the mature fruit. It is a very flat, almost circular, delicate scale whose covering is of a rather dirty orange yellow color which renders it less conspicuous.

The Florida Red Scale (*Chrysomphalus aonidum*) is another leaf scale attacking citrus in Porto Rico, but has not been very abundant during the past year. Its scale covering is almost circular in outline and of a dark purplish-red color.

Wax or Barnacle scales sometimes become abundant, but it is very seldom necessary to resort to control measures against them.

The Rust Mite (*Phyllocoptes oleivorus*) is perhaps the most costly of all the insect pests of citrus here, greatly lowering the returns per box of fruit due to their manner of feeding which turns the fruit a russet-brown in color. These small mites that can scarcely be seen by the naked eye occur at certain seasons by the millions, feeding by extracting the oils from both the leaves and fruit. On the latter the rind becomes brown and of a tough leathery appearance and the fruit itself is greatly reduced in size. This russet fruit always commands a lower price on the market and ordinarily goes to the cannery. The rust mite can be easily controlled usually by a single application of commercial lime sulphur used at the rate of one part of the stock to 66 gallons of water, or by an application of sulphur dust.

Wooly Whitefly (*Aleurothrixus floscosa* Mask.) (Fig. 5.) In addition to being well distributed in the West Indies this species is known to occur in Florida, Mexico, British Guiana, Brazil, Argentine, Canal Zone, Chile and Paraguay. Although it is well distributed over the Island of Porto Rico, occurring on citrus, lignum-vitæ, bananas, almacigo, canna, sea-grape and many other plants, it seems to be kept from doing any serious damage by its minute internal wasp parasite, *Eretmocerus californicus*. In Florida this insect wherever it occurs is one of the most serious pests of citrus and associated with the Common Citrus Whitefly does a great deal of damage. In that state applications of oil-emulsion are an effective control against this pest.

CONTROL OF INSECTS

Cold-mixed Oil Emulsion

Formula I.—*(Missouri Formula)*

Engine oil[1]	2 gals.
Water	1 gal.
Calsium caseinate (Kayso)	4 ozs.

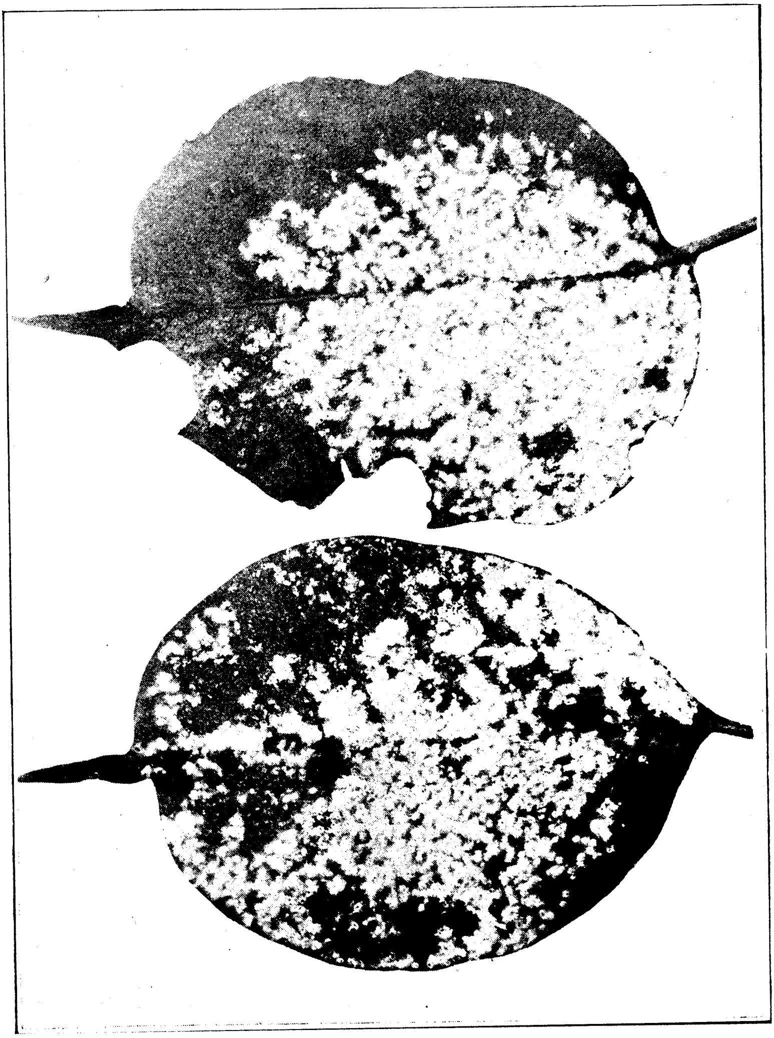

FIG. 5.—Leaves (not citrus) infected with Wooly White Fly

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[1] A number of oils are used for this purpose.

This emulsion can be made easily by means of either a bucket pump on a power sprayer. Make the desired amount of Calcium Caseinate into a paste by slowly adding water and stirring until the full amount of water is added: then add to this the oil, and pump. If a power sprayer is used, put the hose from the tank into a clean barrel using a coarse spray for about a minute and then reducing the opening of the spray nozzle to make a fine spray. One pumping generally produces a good mixture, but it is sometimes desirable to pump twice. Sometimes too much pumping under high pressure produces too thick a mixture which is unsatisfactory.

This formula has many advantages over other formulas: (1) A cold-mixed emulsion easily made at home; (2) better spreading qualities; (3) mixes with lime-sulphur readily and with no injury following; (4) cheaper than other formulas; (5) no clogging of machinery; (6) has a decidedly more agreeable odor than the fish-oil soap emulsion; (7) mixes with hard water; and (8) holds up well for reasonable length of time.

FORMULA II.—*(Improved Government Formula)*

Engine oil	2 gals.
Water	1 gal.
Potash fish-oil soap	2 lbs.

This makes an excellent emulsion when pumped through several times under good pressure. If any trouble is experienced in making, increase the amount of soap.

This formula stands up well for long periods and can be repumped if any separation does take place. However, this emulsion will not mix with lime sulphur solution without curdling and subsequent danger and the disagreeable fish-oil odor is ever present.

FORMULA III.—*(Whitcomb's Formula)*

Engine oil	2 gals.
Water	1 gal.
Fusel oil (Amyl alcohol)	8 ozs.
Fish-oil soap	2 lbs.

Directions.—The fusel oil must be thoroughly stirred into the soap, then the oil added slowly with vigorous stirring and beating until the mixture has the appearance and consistency of salve. Into this is then stirred the water, forming a typical white creamy emulsion.

Owing to the difficulty of obtaining the fusel oil in large quantities and its rather high cost, this formula is not as practical as the two mentioned above. However, it makes a more stable and perfect emulsion and holds up indefinitely without breaking down. It is the easiest formula to make up and does not require even a pump. All the equipment necessary for making it up in small batches is a bowl or tub and a paddle.

FORMULA IV.—*(Yother's Glue Formula)*

Engine oil	2 gals.
Water	1 gal.
Ground glue	1 lb.

Directions.—Dissolve the glue by soaking 10 to 12 hours in the water or by heating; add the oil and pump three times. Because of its being so easy to make and because it will mix with lime-sulphur solution and deep-well water or so-called hard water, this formula is here given especially for the benefit of those growers who have deep artesian wells. It must be used shortly after making, however, as it ferments within a few days. This formula has been recently worked out and is the work of Mr. W. W. Yothers of the U. S. Bureau of Entomology Station at Orlando, Florida, and should be tested out under Porto Rican conditions.

LIME SULPHUR SOLUTION

"Lime-sulphur solution is used extensively in Florida to control sour scab and melanose but has proved ineffective in controlling these diseases on citrus in our territory. It is, however, the best form of sulphur yet devised and is indispensable for the control of red spiders and rust mite. When employed against these pests it is used at the rate of one part to seventy of water and at this strength is very effective.

"The preparation at home of this solution requires too much time, equipment and experience for the ordinary citrus grower to attempt it. Unless done on a large scale the difference in cost between the commercial lime-sulphur solution and the home-made solution is too small to warrant the extra time and trouble.

"There are a number of commercial concentrated solutions of lime-sulphur on the market today and these need only to be diluted with a given amount of water to be ready for immediate use. These, if used at proper strength, are entirely satisfactory. They may be purchased from any of the local wholesale druggists, seed houses or implement dealers. These solutions should be of a density of 33 degrees Baumé.

'Detailed information concerning the making of the home-made lime-sulphur solutions may be had in Farmer's Bulletin 908, of the U. S. Department of Agriculture.

"Lime-sulphur solution is not safe to use in combination with any oil emulsions except that made according to the Missouri cold-stirred formula where the emulsion is made up with calcium caseinate as the emulsifying agent instead of the fish-oil soap or with Yother's glue formula."—From "Insect Pests and Diseases of the Satsuma Orange," by H. L. Dozier, Bulletin No. 1, Gulf Coast Citrus Exchange, August 15, 1924.

SULPHUR DUST

While it is generally conceded that spraying gives a more complete control than dusting, the latter may be a desirable adjunct to spraying, especially on large properties where it is necessary to cover a very large acreage in a limited amount of time. The Rust Mite and Red Spider can both be easily and thoroughly controlled by dusting with Sulphur. The success or failure of this operation, however, will depend largely on the fineness and purity of the dust used, best results being obtained with the extremely finely-divided pure sulphur. This dust should be applied by an orchard dusting machine with sufficient power to thoroughly and uniformly cover both surfaces of the foliage and fruit.

Sulphur dust is very irritating to the eyes of many people and the laborers dislike to use it. Many treatments have been used to overcome this difficulty. Washing the eyes with milk is very satisfactory in some cases.

F. W. Wiedner, Chemist, Stauffer Chemical Co., Texas, makes the following recommendations:

''1. Never rub the eyes while sulphur is being handled. This simply rubs more sulphur than has lodged on the eyelashes into the eyes. The more you rub the eyes the worse they get.

''2. As soon as the work of handling sulphur is finished, wash the eyes with water, so as to remove as much sulphur as possible.

''3. Then borrow a little mentholatum from the family medicine case. Put a little of this material on the tip of one finger and rub over the eyelashes. Don't be afraid to let a little bit get inside each eye. After applying, hold the eyes closed for a few minutes. The tear ducts are opened up and in ten minutes you will have forgotten all about the 'pleasure' of applying sulphur. Very often the most irritation to the eyes is noticed after going to bed at night. The above method will allow restful sleep in a few minutes, and goodness knows a little sleep goes pretty good for after applying sulphur during day.''—The *Florida Grower,* Vol. XXXI, page 8, (June 6th, 1925).

CALCIUM CASEINATE

''Calcium caseinate comes in powdered form as a by-product of creameries, and is sold under the trade names Kayso, Spray Spread, Red Diamond Brand, etc. It is used as a combination spreader and adhesive with Bordeaux mixture, lead arsenate and many other spray materials and is very highly recommended by entomologists and plant pathologists who have been using this material over a wide area during the past two years. It is very cheap, non-poisonous, will not gum nozzle or pump, and if properly used, will give increased coverage, spreading the spray evenly instead of collecting in drops and blotches and thereby requiring less spray and increasing the efficiency of the spray. It adheres much longer than the plain Bordeaux mixture, having greater adhesive qualities and resistance to wind and rain and consequently fewer sprayings are necessary.

''This material is added to Bordeaux mixture as the latter is being thoroughly agitated in the spray tank or more preferably make a creamy mixture of the calcium caseinate in a quart of water then thinning with more water and adding to spray tank. One-half of a pound of calcium caseinate is added to each fifty gallons of the Bordeaux mixture. When used as a spreader at the rate of one-half to a pound to 100 gallons of arsenate of lead spray, calcium caseinate greatly increases the efficiency of this arsenical and adds little to the cost.''

TOBACCO EXTRACTS

''Concentrated solutions of tobacco extract for spraying plant lice and thrips are now sold under various trade names. The two most widely used in our territory at present are 'Black Leaf 40' and Hall's Nicotine Sulphate. Both are highly concentrated preparations, containing 40 per cent of nicotine sulphate, and are effective against plant lice at the strength of one part nicotine sulphate to 800 parts of water. In spraying to control the citrus flower thrips the best strength is at the rate of 13 ounces of nicotine sulphate to 100 gallons of 3–3–50 Bordeaux mixture. The spray to be effective must be directed into the recesses of the bloom or, in the case of plant lice, against the undersides of the leaves as the spray kills only when it comes in contact with the bodies of the insects. When used alone, soap (preferably caustic potash fish-oil soap) should be added at the rate of two pounds to each fifty gallons of water. The soap should be dissolved in a little warm water before adding to the spray.

''In case the grower has time and tobacco stems available, a home-made tobacco spray may be made by soaking 25 pounds of tobacco stems and sweepings in fifty gallons of water for twenty-four hours, stirring occasionally and straining afterwards. After extracting the nicotine, the stems are still of some fertilizer value. Results with the home-made spray, of course, vary with the concentration of the nicotine it contains and the commercial brands of assured 40 per cent nicotine sulphate are therefore better and more uniform in results.''—From ''Insect Pests and Diseases of the Satauma Orange,'' by H. L. Dozier, Bulletin No 1, *Gulf Citrus Grower* (August 15, 1924.)

DISEASES OF CITRUS IN PORTO RICO, CUBA, FLORIDA AND CALIFORNIA

Common name	Cause	Parts Diseased	Porto Rico	Cuba	Florida	California	Treatment in brief
Scab of Verrucosis	Cladosporium citri (1)	Fruit, leaves and twigs	Most serious disease	Very common and sometimes severe on grape fruit	Sometimes severe		Spraying
Greasy spot or black melanose	?	Leaves	Abundant	Abundant	Less Common	Rare	?
True melanose	Phomopsis Citri	Leaves	Not serious	Reported not important	Common and injurious		Pruning and spraying
Stellate melanose	?	Leaves of grape fruit	Not important		Occurs		
Wither tip	Colletotrichum Gloeosporioides	Twigs and leaves	Common, not serious	Common, not serious	Common serious	Less severe than in Florida	Keep trees in good condition. Pruning and spraying
Blossom blight	C. gloeosporioides	Blossoms	On citrus	On citrus	On citrus		Spraying
Anthracnose or spotting	C. gloeosporioides	Fruits	Sometimes serious	Occurs, not serious	Serious at times	Frequent on mature fruit	Prune diseased wood and spray
Wither tip of limes	Gloeosporium limetticolum	Tender twigs, leaves and fruit		Prevalent	Injurious in southern part		Spraying
Citrus canker	Pseudomonas citri	Fruit, leaves and twigs			Serious on grape fruit in parts (3)		Cut out and burn affected trees
Stem end rot	Phomopsis citri	Fruit	Occasional		Common, sometimes prevalent		Prune, Spray: wash fruit in borax before packing
Stem end rot	P. Californica					Occasional	
Stem end rot	Diplodia natalensis	Fruit	Common	Common: most serious fruit rot	Common		Prune, Spray: wash fruit in borax before packing
Blossom end, black rot, or navel end rot	Alternaria citri	Fruit		Common on orange, not important	Rare	On navel oranges	
Altenaria rot	Alternaria sp.					On lemon	
Blossom end rot	Fusarium sp	Fruit	Rare	?	Occurs	Rare	
Blue mold rot	Penicillum italicum	Fruit	Common	Common	Common	Common	Careful handling, wash in borax before packing
Green mold rot	Penicillium digitatum	Fruit	Common	Common	Common	Common	Same as for blue mold
Grey mold	Botrytis cinerea	Lemon fruits				On weak lemons	
Brown rot	Pythiacystis citrophthora	Fruit			?	Serious at times, specially on lemons	Spraying and use of $CuSO_4$ in wash water, and use of hot water (115° to 120° f.)
Cottony rot	Sclerotina Libertiana	Fruit				Sometimes serious on lemons	
Black pit and citrus blast	Pseudomonas citriputeale	Fruit and twigs				Not important except in north California	Protection from wind and spraying

Brown spot	?	Fruit				Sometimes serious on navel oranges	
Tearstain (several forms)	Rust mites, spray oil, Collectotrichum gloeosporiodes, Phomopsis citris	Fruit	Common	Common	Common	Antracnose form occasional	Spraying for fungi and rust mites
Buckskin or shark skin	Probably a form of rust mite injury starting on very young fruit	Fruit	Common	Occasional	Fairly common		Treatment for rust mite
Splitting, creasing, etc	Weather condition	Fruit	Occasional	Occasional sometimes injurious	Fairly common	Common some years	
Smoky disease	Leptothyrium sp.	Fruit		Occasional; not important	Not important		Spraying
Florida scaly spot or nailhead rust.	Cladosporium herbarum var citricolum and C. gloeosporoides	Fruit also on limbs and leaves			Not very important		Pruning, spraying
Green spot or oil burning	Oil liberated by mechanical injury	Fruit		Not important	On oranges picked green and on early oranges	Sometimes serious on lemons	Do not pick when green or wet. careful handling
Peteca	?	Fruit				Sometimes serious on lemons	
Red blotch	?	Fruit				Sometimes troublesome in packing houses	
Bordeaux injury	Spray injury	Leaves	Occurs	Occurs	Occurs	Present, specially after fumigation	Careful work
Oil injury	Spray injury	Fruit	Present	Common; due to poorly prepared emulsions	Present	Common	Careful work
Silver scurf	Thrips	Fruit			Present	Present	
Sun scald	Weather condition	Fruit	Present	Present	Present	Present	
Chemical injuries	Fertilizers					Present	
Mechanical injuries		Fruit				Present	
Knots or gum pockets		Fruit			Rare	Hard knots present	
Internal decline	?	Fruit				On lemons in groves	
Membranous stain	?	Fruit				On lemons in storage	
Sooty mold	Meliola Sp. (lives on insect secretion)	Fruit and leaves	Common	Common	Common	Common	Spraying
Leaf spot	Cercospora sp.	Leaves		Not important	Present		Spraying
Leaf spot	Phyllosticta adustu and Phyllosticta sp	Leaves	Rare		Present		Spraying
Leaf spot (yellow)	?	Leaves			Occasional		
Leaf spot (gum)	?	Leaves		Occasional (5)		Occasional	

DISEASES OF CITRUS IN PORTO RICO, CUBA, FLORIDA AND CALIFORNIA—Continued

Common name	Cause	Parts diseased	Porto Rico	Cuba	Florida	California	Treatment in brief
Leaf mottle (of California) or Frenching (of Florida)	Soil condition or nematodes	Leaves and fruit	Common	Common	Common	Common and sometimes serious	Determine exact cause and treat accordingly
Chlorisis or yellowing of entire leaf	Leaves ?	Leaves		In neglected groves and on unsuitable soils	Common	In a few places	
Exanthema or die-back	Supposed to be due to soils or fertilizers	Twigs, leaves and fruit	Rare	Rare	Very troublesome	Occasional	Apply copper sulphate to soil or spray with Bordeaux oil. Balanced fertilizer General soil improvement
Brown rot gummosis.	Pythiacystis citrophthora	Bark on trunk				Serious on heavy soil	Dig away earth, remove diseased bark and apply fungicide
Grey fungus gummosis	Botritys cinerea	Bark on trunk and sometimes on limbs				In moist coast regions	Remove diseased bark and apply fungicide
Sporosis or California scaly bark	?	Bark on trunk and larger limbs	Not important	Small amount	Common	Common on orange	Prune out diseased limbs or remove diseased bark and apply fungicide or spray
Pink disease	Corticium Salmonicolor	Bark disease	Rare				Prune out and treat with copper sulphate or Bordeaux
Gumming, die back and wither tip	Diplodia natalensis	Twigs and limbs	Very common	Widely distributed and troublesome	Widely distributed; sometimes troublesome. especially grape fruit		Prune out. Soil improvement
Diplodia gummosis						Occasional	Prune and remove diseased bark
Foot rot or "mal di gomma' (6)	Phytophora terrestria	At base of trunk and roots		Common on sweet orange and grape fruit	Destructive	Occasional	Resistant stock; dig away earth; remove diseased bark and apply fungicide
Root rot	Armillaria mellea	Roots				In a few localities	
Foot rot	Fusarium sp.	At base of trunk		Present importance doubtful			
Root rot	Probably soil or drainage	Roots.	Occasional			Present	

Septobasidium	Septobasidium pedicillatum	Twigs		A species of Septobasidium occasionally found on twigs	Occasional		
Twig blight	Sclerotinia libertiana	Twigs				Attacks lemons	Prune out
Citrus knot	Sphaeropsis tumefaciens	Twigs and limbs		Most common on sour orange	Rare		Prune out
Galls	Bacillus tumefaciens	Twigs and limbs				Occasional	Prune out
Wood rot	Schzophyllum commune	Trunk and limbs	Common especially in neglected groves		Rare	Serious on poorly pruned trees	Prune and treat wounds with antiseptic
Wood rot	Polystictus pinsitus	Trunk and branches	Common in neglected groves	In neglected groves			
Blight	Probably due to soil or climatic condition	Entire tree			Destructive on light hammock soils		
Seed bed damping off	Rhizoctonia sp. Sclerotium and other fungi	Small seedlings	Occasional	Common and troublesome	Common and troublesome	Common and troublesome	Soil sterilization, good drainage
Dodder	Cuscuta sp	Seedlings			Occasional	Occasional	Remove from tree by hand pickings
Cassytha	Cassytha	Branches		Occasional	Occasional		
Orchids	Ionophis utriculaoioides and Lechilus labiatus	Branches	Occasional				Remove
Mistletoe	Phthirusa bicolor and P. caribaea	Branches	In some localities, not important				Prune out
Moss	Dendropogon usneoides	Branches			Not important		Remove
Surface growth	Lichen	Trunks and limbs	Common	Common	Common	Occasional in coast region	If necessary remove and spray or wash
Surface growths	Ferns, mosses, orchids, etc.	Limbs	Common				Remove if necessary
Leaf spot	Lichens	Leaves	Common, not important	Sometimes troublesome	Occasional		Spraying
Leaf spot (Algal)	Micoidea parasitica	Leaves	Common, not important	Common sometimes injurious	Occasional		Spraying

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(1) Recent investigations by Anna E. Jenkins of the U. S. Bureau of Plant Industry has recently described the perfect stage of this fungus under the name *Sphaceloma fawcettii*.

(2) *G. limetticolum* has not been found in Porto Rico. What appears to be *C. gloeosporioides* attacks the limes in Porto Rico.

(3) This disease has been almost eliminated from Florida, Alabama and Mississippi. It is reported as abundant in Louisiana.

(4) Bruner of Cuba reports that there is a brown spot in Cuba which is evidently due to insect punctures. It is sometimes injurious on oranges.

(5) The forms in Cuba and California may not be the same.

(6) There is a "gummosis" or "foot rot" which is very common in Porto Rico but *P. terrestria* has not been isolated from it. However, *P. terrestria* has been reported from Porto Rico as attacking peppers, tomatoes and beans.